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I also certify that by virtue of an assignment registered under the Patents Act 1977, the application is now proceeding in the name as substituted.

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Signed R J Sanders

Dated 21 APR 1999

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GB9806778.8

By virtue of a direction given under Section 30 of the Patents Act 1977, the application is proceeding in the name of

SPRINGFORM TECHNOLOGY LIMITED,
Incorporated in the United Kingdom,
Wellington Street,
Long Eaton,
NOTTINGHAM,
NG10 4HT,
United Kingdom

[ADP No. 07636442001]

The Patent Office

GB9806778.8

By virtue of a direction given under Section 30 of the Patents Act 1977, the application is proceeding in the name of

TUDORMALT LIMITED
Wellington Street
Long Eaton
NOTTINGHAM
NG10 4HT
United Kingdom

Incorporated in the United Kingdom

[ADP No. 07508344001]

SEC. (1977 ACT) APPLICATION FILED 26/12/98

Patents Form 1/77

Patents Act 1977

THE PATENT OFFICE
31 MAR 1998

The Patent Office

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P01/7700 25.00 - 9806778.8

Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

The Patent Office

Cardiff Road
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1. Your reference	SAJ/NP921UK	31 MAR 1998
2. Patent application number *(The Patent Office will fill in this part)*		9806778.8
3. Full name, address and postcode of the or of each applicant *(underline all surnames)*	Elson & Robbins Limited Gloucester House Wellington Street Long Eaton Nottingham NG10 4HT	SECTION 30 (1977 ACT) APPLICATION FILED 26.8.98
Patents ADP number *(if you know it)*	5814140002	
If the applicant is a corporate body, give the country/state of its incorporation	United Kingdom	
4. Title of the invention	Apparatus for the production of pocketed coil springs	
5. Name of your agent *(if you have one)*	Lewis & Taylor	
"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*	144 New Walk Leicester LE1 7JA	
Patents ADP number *(if you know it)*	711002	

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:* — Yes

a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or
c) any named applicant is a corporate body.
See note (d))

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	
Description	8
Claim*(s)*	
Abstract	
Drawing*(s)*	4 +4

10. If you are also filing any of the following, state how many against each item.

Priority documents	
Translations of priority documents	
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	
Request for preliminary examination and search *(Patents Form 9/77)*	
Request for substantive examination *(Patents Form 10/77)*	
Any other documents *(please specify)*	

11. I/We request the grant of a patent on the basis of this application.

Signature Date 30 March 1998

12. Name and daytime telephone number of person to contact in the United Kingdom

Dr S A Jones
0116 233 8181

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c) *If there is not enough space for all the relevant details on any part of this form, please continue on a separate sheet of paper and write "see continuation sheet" in the relevant part(s). Any continuation sheet should be attached to this form.*

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Title: Apparatus for the production of pocketed coil springs

This invention relates to apparatus for the production of pocketed coil springs.

Pocketed coil springs, ie strings of springs enclosed within fabric pockets which are joined at their side seams, are widely used in the manufacture of mattresses, cushions and the like.

Apparatus for the production of pocketed coil springs may generally be regarded as comprising two sections: a coiling unit in which the coil is formed and an encapsulation section in which the coil is inserted between two layers of material which are then joined together to form a pocket enclosing the spring.

The coiling of the wire is achieved by the interaction of three components: feed rollers which pull the wire through the coiler, a finger which governs the diameter of the spring as it forms and a spreader which controls its pitch. The relative movements of these components define the pattern of the spring that is formed.

Conventionally, synchronisation is achieved by a complex arrangement of gears and cams, making resetting between one product and another a lengthy operation needing high levels of training and experience. Consequently, economic batch quantities are high and response to special customer requirements is slow. Development of new spring designs is difficult, often relying on the creation of new cam profiles on a trial and error basis.

The encapsulation section relies on the insertion of the fully compressed springs between the sheets of material, most commonly a folded sheet of non-woven fabric, which are then sewn or welded together to produce the individual pocketed springs. Synchronisation of this section is also dependent on mechanical devices such as cams, linkages and a clutch all of which require resetting between products, with resulting loss of productivity and high maintenance costs.

There have now been devised improvements to apparatus for the production of pocketed coil springs which overcome or substantially mitigate the above-mentioned disadvantages.

According to the invention, apparatus for the production of pocketed coil springs comprises a coiling section in which a coil is formed from wire fed to the coiling section, said coiling section comprising coiling elements whose position and/or orientation determines the form of said coil, and an encapsulation section in which the coil is inserted between juxtaposed sheets of material which are joined together to form a pocket enclosing the coil,

wherein said apparatus further comprises programmable control means operably linked to said coiling elements thereby to control the position and/or orientation thereof.

The apparatus according to the invention is advantageous primarily in that the programmable control means may synchronise all operations of the apparatus, thereby eliminating change gears, cams, clutch etc. The time to change between products is reduced to seconds rather than hours, with consequential benefits to productivity and responsiveness, better quality, smaller batch quantities and reduced work in progress stocks. Development of new products and extensions of the product range can be achieved far more easily without any significant loss of time or materials.

The programmable control means preferably comprises a programmable logic controller by which computer-numerical-control (CNC) of the coiling section is achieved. Preferably, the logic controller actuates drive means, most preferably servo motors, by which the positions and/or orientations of the coiling elements can be altered.

Most preferably, control of the coiling unit is exerted by three servo-motors: one for the wire feed rolls, one for the finger and one for the spreader.

Most preferably, the control means stores a number of data arrays or tables which determine the position of the finger and spreader (slave) axes in relation to the position of the feed roller (master) axis, for each spring profile. Suitable tables may be prepared for each spring type to be manufactured, and the appropriate table selected prior to commencement of manufacture of any particular spring type.

Each table may consist of many data points, eg several thousand data points, resulting in complete

control of the spring being formed. In order to facilitate the creation and modification of the tables, they can be created using a computer spreadsheet. This also enables viewing of a graphical representation of the movements of the axes relative to each other prior to the table being downloaded to the logic controller. The use of spreadsheets allows total flexibility in the desired spring profile, eg for development purposes. However, for established spring designs, it may simply be adequate to enter the desired pitch and diameter(s).

Any additional spring parameters, eg the number of convolutions or diameter modifications, may be entered directly via a control panel. This enhances changeovers and allows simple correction for variation in wire properties etc.

After each spring has been formed, the feed roll axis servo motor preferably stops completely to allow the wire to be cut, eg by pneumatic cutter. This is in contrast to a traditional coiling machine where, owing to the inertia in the system, the wire movement is paused by moving the rolls apart from each other whilst they continue to rotate. This requires considerably more moving parts which are prone to mechanical failure.

The apparatus of the present invention makes it possible to achieve higher production speeds than with a conventional coiler. When producing longer springs, this higher speed can lead to instability in the spring as it is being formed which can result in machine stoppages. This problem can be reduced or eliminated by damping excessive oscillations of the springs. This can be achieved using one or more electromagnets mounted at the exit of the coiling unit. The electromagnets hold the spring as it leaves the coiling unit, the spring being mechanically drawn away from the electromagnets as it is conveyed to the encapsulation section.

Preferably, the programmable control means is also operably linked to the encapsulation section, in particular to control movement of material through that unit. Most preferably, a further servo motor controls movement of the material, the increment of that motor corresponding to the desired pocket width, which can thereby be automatically adjusted to suit the spring diameter.

The means by which the springs are transferred to the encapsulation unit and inserted between the

sheets of material may be generally conventional. Preferably, the springs are loaded onto successive radial arms of a rotating wheel. The springs are preferably mechanically compressed as they are conveyed to the encapsulation section so that they are substantially fully compressed when inserted between the sheets of material.

The material in which the pockets are formed may have any suitable form. For example, the material may be either a non-woven or woven fabric. The pockets in the fabric may be formed by any suitable means. Such means include stitching, but it is preferred to form the pockets by thermal welding of the two sheets of material. For this reason, it is preferred that the material be of a fabric which is thermoplastic, and in particular that it be of a non-woven thermoplastic material. One suitable material is a non-woven polypropylene. Most preferably, the two sheets of material are formed by folding of a single sheet having a width approximately double the desired depth of the pockets. In such a case, each pocket is defined between two transverse welds and one longitudinal weld which closes the open end of the pocket through which the spring has been inserted.

Welding of the two sheets of material can be carried out in any suitable fashion. However, it is preferred to use ultrasonic welding. The welds are preferably interrupted, rather than continuous, and are therefore most preferably formed using ultrasonic welding horns with suitably formed, eg castellated, lower edges.

It is particularly preferred that each transverse weld be formed by a pair of castellated welding horns arranged side-by-side. This arrangement is believed to be novel and represents a further aspect of the present invention. It enables production of significantly deeper pocket units, whilst maintaining commonality of spares etc. Moreover, should there be any wear of the welding horn caused by misaligned springs this will be restricted to the adjacent ends of the two horns, which can in time be turned through 180°, avoiding the need to regrind them.

The fixed anvil onto which the or each horn presses the material is preferably provided with a surface coating which acts as a cushion for the welding horn, leading to a more consistent weld and enabling the use of lighter fabrics than is otherwise the case. The surface coating is preferably

a tape applied to the surface of the anvil. The tape is most preferably a polytetrafluoroethylene (PTFE) tape.

The pockets are preferably completed by longitudinal welds formed by a welding horn disposed parallel to the direction of travel of the fabric.

Other components of the apparatus, downstream of the welding horns, may be generally conventional. Such components may include a worm gear which rotates transverse to the direction of travel of the completed pockets and which serves to orient the springs as they expand within the pockets.

The invention will now be described in greater detail, by way of example only, with reference to the accompanying drawings, in which

Figure 1 is a diagrammatic view of a coiling unit forming part of an apparatus according to the invention;

Figure 2 is a schematic view of the coiling unit and spring transfer assembly forming part of the apparatus;

Figure 3 is a detailed scrap view on the line III in Figure 2;

Figure 4 is a schematic view of an encapsulation section forming part of the apparatus; and

Figure 5 is a front schematic view of a transverse ultrasonic welding arrangement forming part of the encapsulation section of Figure 4.

Referring first to Figure 1, a coiling unit of an apparatus according to the invention is shown schematically and comprises three components which determine the form of the coil produced from wire 1 fed into the unit by conventional means. Those three components are a pair of feed rollers 2,3, a coiling finger 4 and a so-called spreader 5. The feed rollers 2,3 determine the axis

along which the wire is fed to the finger 4 and spreader 5. This is the master axis in relation to which the orientational axes (slave axes) of the finger 4 and spreader 5 are adjusted. The orientation of the finger 4 and spreader 5 are governed by servo-motors 6,7 which are controlled by a programmable logic controller (PLC) 8. The PLC 8 is in turn linked to a computer control panel 9. Connection of the control panel 9 to the PLC 8 may be necessary only some of the time, eg for downloading of data to the PLC 8 or monitoring operation of the PLC 8. At other times, eg during normal operation, such connection may be unnecessary.

Figure 2 shows a transfer mechanism by which coils produced in the coiling unit (generally designated in Figure 2 by the numeral 10) are fed to an encapsulation section described below. The transfer mechanism comprises a counter-clockwise rotating wheel 11 with eight radially extending arms 12. Rotation of the wheel 11 is synchronised with the operation of the coiling unit 10 such that springs 20 produced in the coiling unit 10 are fed automatically onto the arms 12 as the arms 12 pass the exit from the coiling unit 10.

As the wheel 11 rotates further, the arms 12 carrying the springs 20 pass along longitudinal slots in a pair of compression plates 13,14, the space between which is progressively reduced, causing the springs 20 to be compressed. The terminal portions of the compression plates 13,14 are disposed parallel and horizontally so as to constitute and a delivery chute for the compressed springs 20 along which they are delivered to the encapsulation unit and in particular to the space between the two leaves of a folded sheet of non-woven fabric 25 (shown in broken lines).

Excessive oscillations of the springs 20 as they exit the coiling unit 10 and are loaded onto the arms 12 are prevented by a pair of electromagnets 27 (see Figure 3) mounted on the topmost parts of the upper compression plate 13, either side of the longitudinal slot 28 running down the centre of that compression plate 13. The electromagnets 27 hold each spring 20 as it exits the coiling unit 10 until the corresponding arm 12 of the wheel 11 transports the spring 20 away.

Figure 4 shows the encapsulation unit 40, the operating axis of which is disposed perpendicular to that of the coiling unit 10. The sheet 25 of fabric is folded by conventional means (not shown) and fed through the encapsulation unit 40 from right to left, as viewed in Figure 4, and in

incremental steps. The sheet 25 passes first between a pair of guide rollers 41. A fixed separating guide (not shown) then parts the two leaves of the sheet 25 sufficiently for a spring 20 to be inserted between them as described above. The sheet 25 is then transported forward by one increment, so that the next spring 20 can be delivered into the space between the leaves of the sheet 25 from the next arm 12 of the wheel 11.

The spring 20 is maintained in a compressed condition by a cover plate 42 which, together with the bed of the encapsulation unit 40, defines a channel through which the encapsulated springs 20 are transported.

Following incremental travel of the sheet 25, the two leaves of the sheet 25 are joined by transverse welds formed by a first reciprocating welding horn arrangement 43 which is described more fully below. A further welding horn 44 forms a longitudinal weld which completes the encapsulation of the springs 20.

A second cover plate 45 extends from the region of the first welding horn arrangement 43, past the further welding horn 44 and also past a drive roller arrangement 46 which acts on the folded fabric sheet 25 so as incrementally to draw the sheet 25 through the encapsulation unit 40.

As the encapsulated springs 20 emerge from the channel between the second cover plate 45 and the bed of the encapsulation unit 40 they expand and are rotated into the desired orientation, in which the spring axis is transverse to the pockets, by a rotating worm 47. The finished product has the form of a string of springs enclosed within pockets formed in the non-woven fabric, the pockets being connected at the weld lines which define the sides of the pockets.

The reciprocating motion of the first welding arrangement 43 and of the further welding horn 44 is synchronised with the incremental actuation of the drive roller arrangement 46, again under the control of the PLC 8.

As shown in Figure 5, the first welding arrangement 43 comprises a pair of ultrasonic welding horns 51,52 arranged side by side. The horns 51,52 reciprocate on a vertical axis, and at the

lowest point of their travel press the fabric sheet 25 onto a corresponding pair of anvils 53,54. The folded sheet 25 of fabric, with a spring 20 inserted between the two leaves of the sheet 25, travels between the anvils 53,54 and the horns 51,52 when the horns 51,52 are raised.

By using two welding horns 51,52 it is possible to achieve a greater length of weld than would be possible using only one horn, and hence deeper pockets containing longer springs may be formed.

The lower edge of each horn 51,52 is castellated. After each incremental travel of the sheet 25, the horns 51,52 are lowered and compress the two leaves of the sheet 25 together and join the two leaves in a weld. Because of the castellated form of the lower edge of each horn 51,52, the weld has the form of an interrupted, rather than continuous, line. This is found to confer greater tensile strength on the finished string of pocketed springs.

The upper surface of each of the anvils 53,54 carries a strip of polytetrafluoroethylene tape 55,56. This cushions the contact of the welding horns 51,52 with the fabric 25 and leads to more consistent weld formation and enables the use of lighter weight fabrics than would otherwise be the case.

FIG 1

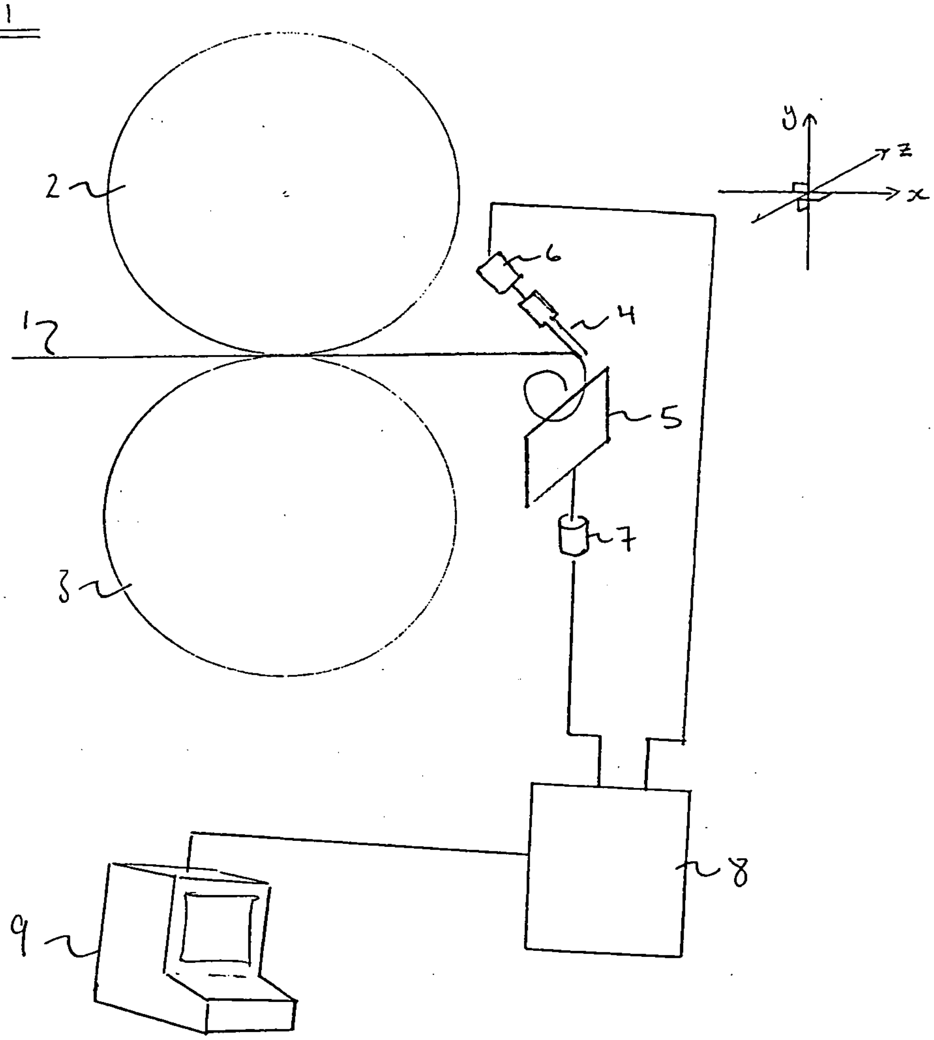

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FIG 2

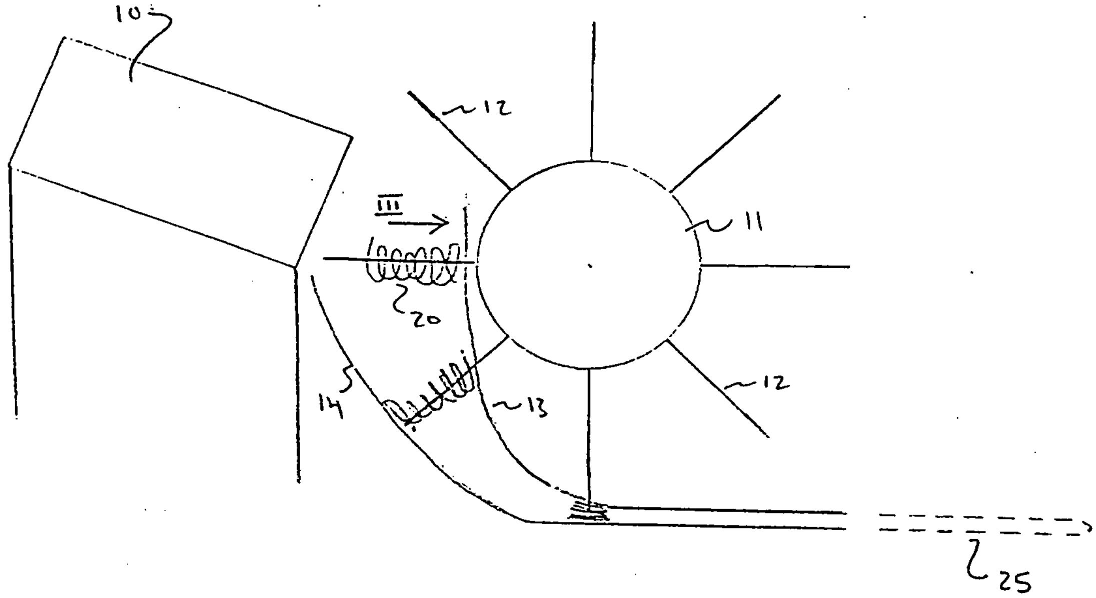

FIG 3

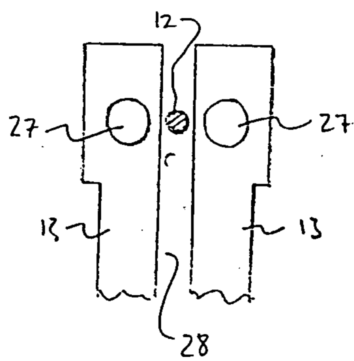

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FIG 4

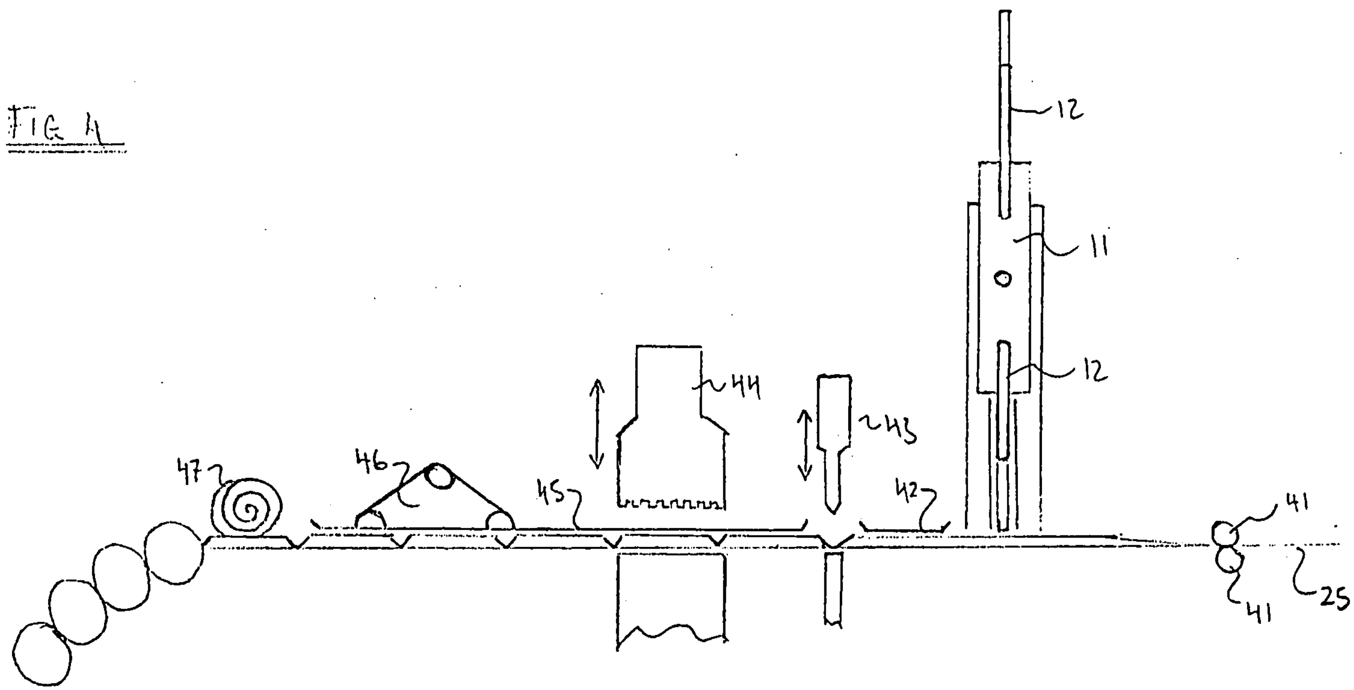
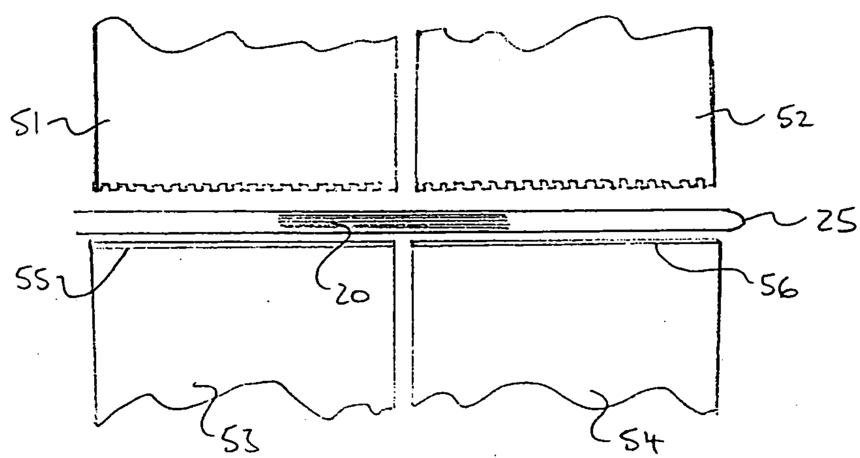


FIG 5



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AGENT : Lewis & Taylor

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